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Roger Berger

Do Trained Actors Learn Strategic Behaviour or Are They Selected into Their Positions?

Empirical Evidence from Penalty Kicking.

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Redaktion: Dr. Ivar Krumpal

Kontakt Institut für Soziologie
Universität Leipzig
Beethovenstr. 15
04107 Leipzig

Tel +49 (0) 341 9735 693 (Ivar Krumpal)
640 (Sekretariat Fr. Müller)
Fax +49 (0) 341 9735 669

Email: krumpal@sozio.uni-leipzig.de
Net: http://www.uni-leipzig.de/~sozio/content/site/projekte_berichte.php

Abstract: Do Trained Actors Learn Strategic Behaviour or Are They Selected into Their Positions? Empirical Evidence from Penalty Kicking.

This paper studies if the Minimax theorem holds for the behaviour of trained and untrained actors in the field. This is explored with data from 1043 football penalty kicks from professionals of the German Bundesliga and for 268 penalty kicks from untrained players. Minimax makes good predictions about the collective patterns emerging from the behaviour of experienced actors, as well as about their individual strategic actions. However, this is not true for untrained actors. In the next step it is explored if, the professional players learned their behaviour, or if they were selected into their roles because they had the required abilities. The data suggests that the professionals were selected by the competitive conditions of professional sports.

Keywords: Minimax, untrained actors, learning, selection..

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1 Introduction

Zero-sum-interactions form an interesting class of social interactions. The actors have opposing interests, and as long as both actors do not have completely altruistic preferences,[1] then the actors must be selfish. In reality, zero-sum-interactions are often found in situations where ego tries to catch alter, and alter tries to escape from ego. An often cited example is the escape of Prof. Moriarty from Sherlock Holmes in A.C. Doyles Novel "The final problem" (cf. also "Hide and Seek" from Rosenthal et al. 2003). Typical sociological phenomena that include zero-sum-interactions are crime and deviant behaviour of different sorts (Tsebelis 1990). E.g., a thief tries to steal the property of his victim. Potential victims try to evade thieves. The police try to capture the thieves and the thieves try to evade the police. A corresponding white-collar crime is tax fraud. A tax evader tries not to be caught by tax authorities, and authorities try to detect tax fraud. Similarly terrorists try to hurt their victims. People try to evade terrorism and authorities try to prevent acts of terrorism. Also interactions in sports as they are analysed here, typically are zero-sum-interactions.

In such interactions typically there is a "gewisser Zirkel im Wesen der Sache" [a certain circle in the character of the matter] (von Neumann 1928: 295). This means that a thief will try to steal in situations where the potential victims are inattentive, and where there is no police around. In turn, potential victims try to be attentive exactly when there are thieves around, and the police tries to be in places where thievery is expected. Thieves try to anticipate this provisions, and will not steal when their victims are vigilant, and they are prone to be caught, and so on and so for. Indeed, not only a few sociologists think that such zero-sum-interactions are logically unsolvable, and therefore a priori unpredictable (cf. Berger and Hammer 2007a; Gansmann 2006; Luhmann 1986). However, as early as 1928 von Neumann found the theoretical solution for an utility maximizing behaviour in such zero-sum-interactions with the Minimax theorem and the mixed strategy equilibrium resulting from it. Actors that behave according to the Minimax strategy optimise their outcome and cannot be exploited by any other strategic behaviour.

Several authors engaged in the empirical verification of the Minimax theorem (Chiappori et al. 2002; Hsu et al. 2007; Klaassen and Magnus 2001; Levitt et al. 2007; McKelvey et al. 2000; Mookherjee and Sopher 2004; Moschini 2004; Ochs 1995; O'Neill 1987, 1991; Palacios-Huerta 2003; Palacios-Huerta and Volij 2008; Rapoport and Boebel 1992; Rosenthal et al. 2003; Shachat 2002; Walker and Wooders 2001) with the following results: (1) Aggregate patterns are better explained by Minimax than individual

[1] This case is obviously extremley rare in reality.

action. (2) Trained actors (namely: professional athletes) tend to behave optimally in zero-sum-interactions, while untrained actors hardly do. (3) Particularly, optimal behaviour on the individual level is primarly found in professional athletes, but not with untrained actors. These three results are valid for examinations in artificial laboratory surroundings. (4) In *real* situations with high incentives professional athletes seem to act optimally as well.[2] For penalty kicks Bar-Eli et al. (2007) and Leiniger and Ockenfels (2007), doubt if this holds for interactions more complex than with 2×2 options.

Yet from a sociological point of view some questions remain unanswered. First, do *untrained* actors also behave optimally in *real* zero-sum-interactions? In sociological phenomena of that kind, some actors are experienced and others are not. Sometimes trained actors interact with trained actors (e.g., thieves and the police, deceptive tax consultants and tax authorities), sometimes trained actors interact with untrained ones (e.g., thieves and their victims, tax authorities and occasional tax evaders), and sometimes untrained actors interact with untrained ones (e.g., suicide bombers and victims of terror). If it should appear that untrained actors do not behave optimally in in real zero-sum-interactions, a second question arises: Why do experienced actors behave optimally in real zero-sum-interactions as opposed to unexperienced ones? Is optimal strategic behaviour learned, or were trained actors selected into their positions because they have had the required abilities?

Empirically, these questions are best examined with zero-sum-situations where similar and highly standardised data of trained and untrained actors is available. Additionally, in order to test some theoretical propositions it is necessary to measure the cardinal utility (Varian 1992) that actors derive from their outcomes. Therefore, as others have done before, penalty kicks in football are used here for empirical testing. This interaction is simple, and easy to observe with professional athletes and untrained players. Furthermore, it seems plausible that scoring one goal has the same utility for all kickers, and that this utility is exactly opposed to the utility of a failed penalty kick. In addition, the same holds for the goalkeepers. A stopped penalty kick has the same cardinal utility for all goalies, and has the same absolute value as a received goal.

The paper is organised as follows: In the next section (2) the Minimax theorem is applied to penalty kicking. Here, this interaction is modeled with the centre option as a 3×3 decision. The concluding patterns on the aggregate level and for the individual behaviour of single players are derived. In the following empirical part these hypotheses are examined with two data sets (cf. section 3): One consists of data on all 1043 penalty kicks that occurred during the seasons 1993/94 to 2003/04 in the first league of Germany (Bundesliga). The second set consists of data from visitors at a science fair

[2]Kovash and Levitt (2009) form an exception.

who kicked 268 penalties to trained youth goalkeepers. The results in section 4 show that for professional players the emerging patterns on the aggregate level, as well as the behaviour of indvidual athletes, are predicted quite well by the Minimax theorem. However, this is not true for amateur players. Neither the aggregate patterns, nor the individual decisions of unexperienced actors are hardly predictable by Minimax. Section 5 analyses if the strategically optimised action of professional players is the result of individual training, or if professionals were selected into their positions. With further inspection of the data and additional evidence it can be shown that selection seems to be of more importance than individual training. Section 6 concludes the paper.

2 Theory: Minimax and penalty kicking in football

In zero-sum-interactions the actors' interests are exactly opposed. One actor's profit corresponds to the other actor's loss. Typical for that is a circle of mutual expectations, which seems to lead to an infinite regress. This is well illustrated with penalty kicking. There the player tries to kick the ball into the goal from a distance of 11.00m. The size of the goal (7.32m wide and 2.44m high) forces the goalkeeper to form an expectation about the side chosen by the kicker. If the goalkeeper jumps only shortly after the ball was kicked he could never save the ball because human reaction time and jumping power would be insufficient (Johanni and Tschachner 2005). Therefore the goalkeeper must decide for one side of the goal if he hopes to reach the ball. If his assumption regarding the corner chosen by the kicker is correct, his chance of saving the ball is improved, but still is not high. In principle, the goalkeeper could also choose to stay in the centre. This strategy has the advantage that the ball can be saved mostly if it is actually directed to the centre. But with the same certainty the result will be a goal if this is not the case and the kick is directed to one of the corners. There is the possibility to save a ball directed at the centre with the feet when jumping to one of the sides. But because legs are not as flexible and manoeuvrable as arms, such a defence is hard to manage and requires some luck.[3] The strategic decision making problem now occurs because the penalty kicker is aware of the goalkeeper's options. He will adjust his expectations accordingly. If he assumes that the goalkeeper will jump to the left he will kick to the right and vice versa. This will in turn prompt the goalkeeper to choose the opposite

[3]While the shoulder joint allows for movements in all directions, the hip joint restricts movement to a certain radius (personal communication with Daniel Ackermann and Jochen Berger, Departement of Sports, University of Leipzig). Table 5 gives a hint about the empirical probabilities of a missed goal with a kick to the centre (25.8% when jumping left, 36% when jumping right). However, we do not know if the ball was stopped with the feet.

side, etc. Optionally, the kicker may also kick to the centre if he expects the goalkeeper to jump to either side.[4] If the goalkeeper is expecting this he may also stay in the centre, etc.

The optimal behaviour in such a situation consists of being unpredictable. This is the case if the expected utilities for all the opponent's alternatives are equal and the opponent therefore is indifferent towards his alternatives. Therefore, the goalkeeper should behave in a manner so that the probability of scoring for the kicker is equal for each area of the goal. The kicker in turn should make his choice so that the goalkeeper's saving probability is equally high for all areas of the goal. This condition can be applied to any number of the goal's areas. The theoretical conclusions do not depend on the considered areas of the goal. Rather, the appropriate model is set by the available data. Therefore, a model with three options is used here.

The resulting solution is an equilibrium in mixed strategies in which both players randomly choose their alternatives from a certain probability distribution. To calculate these probabilities it is necessary to determine the players' cardinal utilities (Varian 1992). This can be done plausibly and easily with penalty kicks. For this purpose it is assumed that a scored goal has the same cardinal utility in an absolute value as a received goal, namely 1. This actually makes the match a zero-sum-interaction (however: see Bar-Eli et al. 2007; Leiniger and Ockenfels 2007).[5]

With this prerequisite the Minimax theorem can be applied to penalty kicks. Thus, the theory used therefore is standard game theory (see e.g. Dixith and Skeath 2004 for illustrations with sports). Several technical elements of penalty kicks are added, such as the fact that a kicker has a favoured kicking foot (similar to right-handedness). Every player (also professional ones) uses this kicking foot. For anatomic reasons a right-footed player kicks the ball with his right foot more precisely, harder and therefore with a higher probability of scoring to the left (as seen by the kicker) than to the right (and vice versa).[6] With kickers shooting to the right, therefore, the right side, as seen by the

[4]A kick to the centre has the favourable characteristic that the ball at least does not miss the goal. The aspect of not missing the goal at all is of minor importance for accurate kicking trained players. But it is important for untrained players (see below section 2.1 and 4.1.2).

[5]Bar-Eli et al. (2007) doubt this for professional goalkeepers in 3×3 interactions. Yet, they do not model the zero-sum-interaction as a strategic situation of interdependence, but as parametric decision under risk. In addition, this paper suffers from several empirical flaws (cf. Berger 2009). Leiniger and Ockenfels (2007) apply game theory, but nevertheless dismiss the assumption that penalty kicking is a zero-sum-interaction for some models. These models are not tested empirically and are mainly based on the expert opinion and anecdotes of professional keepers (Schumacher, Butt). Some of these stylized facts used by Leiniger and Ockenfels (2007) are proved to be wrong in this study (see section 2.2, 4.2). One hypothesis of Leiniger and Ockenfels (2007) is tested (cf. H7 below).

[6]Personal communication with Daniel Ackermann and Jochen Berger, Departement of Sports, Uni-

goalkeeper, is described as the "natural" (N) side for goalkeeper *and* kicker. For kickers shooting with the left foot the natural side is the left side, as seen by the goalkeeper, which is also described as "natural". Each opposite side is for purposes of legibility described as "left" (L). The centre remains unchanged in this view. Yet, depending on the exact angle of run-up, the kicking technique remains the same for kicks to the centre and to the natural side.[7] With this technical argument kicks to the centre can be counted as kicks to the natural side (cf. Palacios-Huerta 2003). We will refer to this procedure below when case numbers are too small to make a difference between the centre and the natural side.

The kicking foot and with it the kicker's natural side are known by the goalkeeper from the kicker's run-up (from the left in order to kick with the right foot, and vice versa). And the kicker is aware of the fact that the goalkeeper knows his natural side etc. Thus, since the kicking foot is common knowledge (e.g. Geanakoplos 1992), neither player has an advantage of this information, and the strategic situation remains unchanged by this asymmetry. The same is true for any feint of kicker and goalkeeper. They do not change the game strategically and its circular characteristic, because the opponent never knows if the feint is a feint or not.[8]

Several authors demonstrated the derivation of hypotheses on penalty kicks from the Minimax theorem starting from the aforementioned game description (Chiappori et al. 2002; Moschini 2004; Palacios-Huerta 2003). In the next section we present the assumptions of the fundamental model of Chiappori et al. (2002) without repeating the complete underlying analyses.

2.1 Theoretical assumptions

Figure 1 shows the payoff matrix of the game with the probabilities of scoring for the kicker.[9] From the above considerations some assumptions result about the sequence of the probabilities of scoring a goal depending on the chosen sides, namely: (1) The

versity of Leipzig.

[7]Personal communication with Daniel Ackermann, Departement of Sports, University of Leipzig.

[8]It is worthy to give some examples on this behaviour, because there exist many anecdotes about it. E.g. a kicker can "lean into" one side while running up, feigning that they will kick to this side. However, the goalie does not know if the kicker is only feigning, or really shooting into this corner, etc. The goalie can position himself closer to one of the posts, in order to give the impression to the kicker, that he will jump to the closer post. But, the kicker does not know if the goalkeeper is only trying to bluff him, or if he will actually jump to this side, etc.

[9]Because the cardinal utility of scoring a goal is assumed to be 1, the probabilities correspond to the payoff.

Figure 1: Payoff matrix (probabilities of scoring) of the penalty kick for the kicker with strategies left, centre and right.

		GOALIE		
		left	*centre*	*right*
KICKER	*left*	P_L	Q_L	Q_L
	centre	M	ν	M
	right	Q_R	Q_R	P_R

The strategy choice "right" indicates the kick or the jump to the kicker's natural side.

probability of scoring is obviously higher if the keeper chooses the wrong side as opposed to choosing the same side as the kicker ($Q_R > P_L$ and $Q_L > P_R$). (2) Also, a kick to the opposite of the goalkeepers side has a higher probability of conversion than a kick to this same side when the goalkeeper stays in the centre ($Q_R > M$ and $Q_L > M$). In the latter case the goalkeeper has a chance to stop a ball if it is not precisely directed close to the post. In the former case, there is no chance to stop the ball at all. (3a) Of two misguessed kicks on the goalkeepers part, kicks to the natural side have a probability of being converted that is equal or higher than the probability for kicks to the "left" side ($Q_R \geq Q_L$). This is due to the higher speed and especially precision of kicks to the natural side. (3b) For the same reason, of two kicks where the goalkeepers chooses the correct side, kicks to the natural side have a probability of being converted that is equal or higher than the probability for kicks to the "left" side ($P_R \geq P_L$). (4) Because kicks to the natural side are easier to convert, it is less important if the keeper guesses the natural side correctly, than it is on the "left" side ($Q_L - P_L \geq Q_R - P_R$).

Because the game is considered a zero-sum-interaction the same assumptions (just reversed) are made for the goalies. In addition, it is assumed that these assumptions are common knowledge (e.g. Geanakoplos 1992) for the players. For the empirical analysis it is important to remember that the above assumptions actually hold for specific penalty kicks. Only if there is *no heterogeneity* in the population of all penalty kicks, do the above assumptions hold for the aggregate of all penalties as well.

From tables 5 it can be learned that for the professional athletes of the Bundesliga the assumptions hold, with the partial exception of assumption (3). The scoring probabilities for [N, L] are slightly lower (91.8%) than those for [L, N] (96.0). From table 9 and 10 it can be seen that for the untrained players, the last assumption (4) does not hold at all. With these assumptions a set of testable hypotheses for the macro level of

social patterns and for the micro level of individual players can be derived. Not all assumptions are necessary for all hypotheses. Therefore the consequences of the unfulfilled assumptions will be discussed with the corresponding hypotheses.

2.2 Theory: macro level

If kickers and goalkeepers behave strategically optimal in a penalty kick, the following statements should apply to the emergent aggregate patterns:

H1: The randomisation of kickers and goalies are independent of each other.

H2: The combination [natural, natural] ([N, N]) is more probable than both the combinations [left, natural] ([L, N]) and [natural, left] ([N, L]). These however, are more probable than the combination [left, left] ([L, L]).

This hypothesis is, among others, based on assumption (4). If the hypothesis cannot be empirically justified for the amateur players, this might be attributed to the assumption only being partly fulfilled.

H3: The probability of kickers shooting to the centre is higher than the probability of goalkeepers remaining in the centre.

H4: The probability of goalkeepers choosing the kicker's natural side is higher than the one of the kicker shooting the ball there.

H5: **(a)** The kickers have a higher probability of choosing their natural sides than of choosing their other sides.

(b) The goalkeepers have a higher probability of choosing the kickers' natural sides than of choosing their other sides.

This hypothesis is based on assumption (3). If the hypothesis cannot be empirically justified for professional players this might be because this assumption is only partly fulfilled.

H6: **(a)** The probability of scoring a goal is equally high, regardless of the side the kicker shoots to.

(b) The probability of saving a goal is equally high, regardless of the side the goalkeepers chooses.

These hypotheses are interesting from a sociological point of view for several reasons. (1) They refer to aggregates which are the explananda of sociology (e.g. Coleman 1986). (2) Emergent aggregate patterns are not the trivial result (e.g., by averaging) of the

actors' micro motives. But although for the goalkeeper the easiest kicks to stop are the ones to the centre, this does not mean that they should choose this option most often. On the contrary, because the players interact, the opponents outcome must be taken into account which leads to H3 (cf. Berger 2009).

Leininger and Ockenfels (2007) postulate a game theoretic model including a kick to the centre as well. This kick has the favourable characteristic that the ball will at least not miss the goal. However, for trained actors Leininger and Ockenfels (2007), do not expect to find any empirical difference between their game theoretic model compared to the here presented Minimax model. Professional players with good technical abilities hardly ever suspect that the ball flies into an unintended direction. This is different for untrained scorers. Due to lacking technical abilities there is always a chance that the ball will deviate significantly from the location aimed at. Therefore, a kick to the centre is favourable because it offers the highest fault tolerance. Even if poorly kicked, there is chance that the ball is directed to the goal and by that fulfills the essential prerequisite for a successful kick. Thus, Leininger and Ockenfels (2007) conclude the following:

H7: Trained kickers shoot to the centre less frequently than untrained kickers.

2.3 Theory: micro level

Some hypotheses do not refer exclusively to a social phenomenon which can be assigned to the interaction of both actors, but can instead also be applied to individual actors. If they behave optimally in penalty kicks the following hypotheses should apply.

H5$_{ind}$: (a) The kicker has a higher probability of choosing his natural side than of choosing the other side.

(b) The goalkeeper has a higher probability of choosing the kicker's natural side than of choosing his other side.

H6$_{ind}$: (a) The probability of scoring a goal is equally high, regardless of the side the kicker shoots to.

(b) The probability of saving a goal is equally high, regardless of the side the goalkeepers chooses.

Furthermore, hypothetical statements concerning the behaviour in a sequence of penalties for single players can be made. Valid is here as well that the players have to remain unpredictable for their opponents. This means that the behaviour during a penalty cannot be concluded from the prior kick. Such a pattern (e.g. "every second kick to the natural side") could be exploited by the opponent. With optimising behaviour of

individual players both statements on strategies in a sequence of penalties must therefore apply.[10]

H8: **(a)** Kickers generate a random order of "left" and the natural side.

(b) Goalkeepers generate a random order of "left" and the natural side.

3 Data

These hypotheses are examined with two data sets. One consists of data on penalty kicks from professional players. It contains data on individual players who were repeatedly involved in penalty kicks and therefore allows for tests on individual level. The second data set was collected through observing penalties of untrained amateurs and is not suitable for individual testing.

3.1 Data on trained professional players

This data set consists of data on all 1043 penalty kicks that occurred during the seasons 1993/94 to 2003/04 in the first league of Germany (Bundesliga). The data was collected by four professional observers coding the same game independently and simultaneously. This data collection takes place routinely by the firm Impire AG in order to sell up-to-date data sets to the observed teams and their opponents. Therefore the data can be expected to be most objective.

3.2 Data on untrained players

Data on untrained players was collected at a science fair. This fair was one event that took place within the scope of the "year of mathematics", which the German government had proclaimed in 2008. It took place on the most central square in Leipzig. The visitors were to be given an understanding of the mathematical elements of everyday situations. One stand at the fair was occupied with football, and amongst other things the Minimax theorem and penalty kicks. The fair occurred simultaneously to the European Football Championship, which caused a high interest in the stand. Admission was free and the fair was attended by interested visitors and pupils as well as tourists and passers-by. In front of the exhibition tent a goal was set up. Due to spatial concerns it was a youth goal (5.00m wide and 2.00m high). The penalties were kicked from a distance of 9.00m.

[10] Anticipating the empirical test, these hypotheses are stated for only two alternatives, since insufficient data is available for a test with three options.

Table 1: Description of penalties in the professional Bundesliga.

	direction of kicks and jumps, respectively							
	kicking foot		actual/natural			result		
	L	R	L	centre	R	goal	missed	saved
kickers	377	666	441/433	151	451/459	788	51	
goalies			520/542	17	506/484			204

The first figure in the cell of kicking or jumping direction L (left) and R (right) indicates the actual direction of the kick or the jump, each as seen by the executing player. The second number refers to the natural and unnatural "left" direction as seen by the goalkeeper; kicks and jumps to the right side (as seen by the goalkeeper) with right-footed players are counted as natural and with left-footed players as unnatural. "missed" stands for the ball hitting the goal frame or missing the goal, "saved" indicates "saved by the goalkeeper".

These dimensions comply with the youth football guidelines. The bottom surface in the goal was padded with mats, which allowed for safe jumps (see figure 2).

There were two youth goalkeepers aged 12 from a local club. The goalkeepers received a small compensation and were - apart from the compensation - highly motivated. They had been playing football for six, respectively seven years and were trained well.[11] By their own account they were striving to emulate their role model Adler.[12] Visitors could kick a penalty after filling out a questionnaire which asked for age, sex and kicking foot (left or right). Furthermore, they were asked whether they had ever played organised football, and if so, for how long.[13] The ball was released upon the blow of a whistle, which increased the situation's seriousness. All the visitors were highly intent upon placing the ball in the goal, and were not considered with the keepers young age. Children and adolescents were especially interested in the opportunity. However, also a significant number of older visitors, mainly those who had once played football, took part as well. This self-selection certainly leads to the fact that the observed sample is biased, when compared with the normal population. Women were particularly underrepresented (only 9% of the participants were female).[14] And clearly most participants had an affinity towards football. Because of that, the situation did not exactly comply with one under

[11]Sometimes they were accompanied by their special goalkeeping coach.

[12]The goalkeeper Adler also comes from Leipzig and is a keeper of the German national team.

[13]The goalkeepers were not privy to the information in the questionnaires. The kicking foot however, became apparent to them through the run-up. They could also estimate the scorers age, but still did not know about the kickers football knowledge.

[14]In contrast to the US, in Europe football is predominately a male sport.

Figure 2: Goal and goalkeeper on the science fair

professional conditions. The following points were different: (1) All the dimensions were smaller. (2) The goalkeepers had higher technical abilities, better equipment and preparation than the kickers who queued up wearing casual clothes. Both leads to the fact that in this setting the goalkeeper had a higher chance of saving the ball than under professional conditions. This is also reflected in the data. With the untrained players approximately two out of five kicks resulted in a goal. With professional players this is the case in about three out of four kicks (cf. table 5 and 9/10). However, the strategic situation remained unaffected by that, since the game matrix stayed the same. Therefore, the circle of expectations concerning the directions of jumps and kicks existed in a way that it does in professional players. This is no longer valid as soon as the ball is moving slowly enough such that the goalkeeper has enough time to react and jump

Table 2: Description of untrained players.

	n	$\bar{x}$	s	min	max
age (in years)	268	23.73	10.32	11	49
sex (1=male)	268	0.91	0.29	0	1
right-footedness (1=yes)	268	0.91	0.29	0	1
ever played football? (1=yes)	268	0.46	0.50	0	1
if yes: how many years?	122	6.81	6.34	1	36

before the ball has travelled the complete 9m to the goal line. This happens rarely, even with untrained kickers, who usually do not lack power, but precision. With very young and old kickers however, leg power can be insufficient for giving the ball necessary speed. For that reason, kickers younger than 10 and older than 50 were excluded from the data set. Of the former there were 33 and of the latter only 9. These cut-off points are only justified by common sense, and they do not ensure that there indeed was a simultaneous decision made by all remaining participants. With single kickers it was obvious for all people involved that the ball was not kicked hard enough. If these cases had also been excluded, (e.g. directly during observation) it may justly be objected that by doing so each desired empirical result could be obtained. Therefore, we abstain from this purely arbitrary reduction. If it becomes clear that the Minimax theorem is also valid in this case, then it would be a strong argument in favour of its application to most different zero-sum-interactions.

When interpreting the results it must be kept in mind that the data of the untrained players are less precise than those of the professional ones, since the codification of the penalty kick had to be done immediately the observer. The data of the professional players were collected by four independent observers with the aid of records. Table 2 describes the untrained players and table 3 their behaviour during penalty kicks.

4 Results

Here we present the results for the aggregate social patterns: first for the professional players and then for the untrained players. With the latter it is denoted whether the kickers had ever played football before (amateurs) or not (absolute beginners). The first group is assumed to be familiar with the strategic decision situation. If any learning effect occurs, trained amateurs should behave more optimally than entirely untrained beginners. In this case, the goalkeepers should be a bit better on average than the

Table 3: Description of penalties kicked by untrained players.

	direction of kicks and jumps, respectively							
	kicking foot		actual/natural			result		
	L	R	L	centre	R	goal	missed	saved
kickers	24	244	125/103	46	97/119	106	46	
goalies			60/58	46	162/164			116

The first figure in the cell of kicking or jumping direction L (left) and R (right) indicates the actual direction of the kick or the jump, each as seen by the executing player. The second number refers to the natural and unnatural "left" direction as seen by the goalkeeper; kicks and jumps to the right side (as seen by the goalkeeper) with right-footed players are counted as natural and with left-footed players as unnatural. "missed" stands for the ball hitting the goal frame or missing the goal, "saved" indicates "saved by the goalkeeper".

trained amateurs, since they have to make the strategic decision very often and should hence become better. In addition, they were a priori better trained than the average kicker.

4.1 Results: macro level

With the test on the macro level a statistical aggregation problem arises. The empirically measured frequency and proportions reflect the theoretically expected probability only if all players and penalty kick situations are homogenous. It is however possible that, e.g. for the professionals a penalty kick at the beginning of a match - at a moment when there is still time for an opportunity to compensate for a missed kick - represents a different interaction than one at the end of the match. If in the population of the observed penalty kick situations such a heterogeneity existed, the probability measurement would be biased. For the data set of the German Bundesliga at least some possible assumptions of heterogeneity can be excluded. There are homogeneous penalty kick situations independent from the score, playing time, the player's kicking foot and the player acting (cf. Berger und Hammer 2007a and 2007b). Heterogeneity which was theoretically already included exists in the player's kicking direction, which depends on his kicking foot. However, the potential sources of heterogeneity are principally unknown. This is valid especially for the untrained players' data set. On the one hand it has to be assumed that more heterogeneity is present there than with the professional players. On the other hand it is not known what this heterogeneity can be ascribed to. Therefore, an adequate control is not possible.

Chiappori et al. (2002: 1143) show that some of the postulated hypotheses are robust, and unaffected by unobserved heterogeneity in the data. For the particular case of our data, hypotheses 2, 3 and 5 should also hold with heterogeneity in the data, as long as the hypotheses are expressed as statements of frequencies instead of as statements of probabilities. Because this analysis compares trained actors to untrained ones, a test strategy is pursued where the hypotheses are tested as statements of frequencies, as far as this is feasible. Otherwise this difficulty is referred to in the interpretation.

4.1.1 Results: trained players

The hypotheses were tested in the outlined order for professional players from the German Bundesliga.

H1: Independence of kickers' and goalies' strategies. Table 4 shows the combined strategy choices of kickers and goalkeepers in the German Bundesliga. This allows to estimate the association between the kicker's shooting direction and the goalkeeper's decision. There is no association ($\chi^2 = 2.4, df = 4, p = 0.66$).

Table 4: Empirical distribution of strategies of professional Bundesliga goalies and kickers in absolute frequencies and percentages.

		goalkeeper							
		left		*centre*		*right*			
kicker	*left*	202	19.4%	6	0.6%	225	21.6%	433	41.5%
	centre	62	5.9%	3	0.3%	86	8.2%	151	14.5%
	right	220	21.1%	8	0.8%	231	22.1%	459	44.0%
		484	46.4%	17	1.6%	542	52.0%	1043	100%

The strategy choice "right" indicates the kick or the jump to the kicker's natural side. (Percentages may not add up to 100 due to rounding.)

H2: Sequence of strategy combinations: As predicted, the combination [N, N] is most likely (22.1%), followed by [L, N] (21.6%) and [N, L] (21.1%). The rarest of the four combinations is [L, L] (19.4%). A maximum-likelihood test shows that the differences between [N, N] and [L, L], as well as between [N, N] and [L, N] are not significant. So the predicted order is found with partly lacking significance.

H3: Probability of the option "centre": It is clearly observable that the kickers have a significantly higher probability of kicking the ball into the centre than the goalkeepers have of staying there ($t = 17.1$).

H4: Choice of natural side by goalkeeper and kicker together: The probability of goalkeepers jumping to the natural side (52.0%) is higher than that of kickers shooting

Table 5: Empirical distribution of scoring probability percentages for professional kickers in the Bundesliga.

		goalie			
		left	*centre*	*right*	
kicker	*left*	52.5	83.3	96.0	75.5
	centre	74.2	33.3	64.0	67.5
	right	91.8	100.0	64.5	78.2
		73.1	82.4	77.5	75.6

The strategy choice "right" indicates the kick or the jump to the kicker's natural side. The figures in the cells correspond to the empirical probabilities of scoring (i.e. the ratio of scored goals and kicks) for the kicker in the respective strategy combination. The probability of saving for the goalkeeper is the resulting converse probability.

the ball there (44.0%). Corresponding t-tests show that this discrepancy is not significant. If however, it is assumed that there is unidentified heterogeneity in the data and the hypothesis is expressed as frequencies, the present discrepancies definitely remain significant ($t = -2.6$).

H5: Choice of natural side by the kicker and goalkeeper: The kickers actually choose the natural right side in 44.0% of all cases and therefore significantly more often than the left side with 41.5% of all cases (KS test: z=15.5, asymptotical significant p=0.00).[15]

The same is true for goalkeepers who seem to anticipate that it is favourable for the kicker to shoot to the natural side and jump to this side with a significantly higher probability (52.0%) than to the left side (46.4%). This discrepancy is significant (KS test: z=16.9, asymptotical significant p=0.000).[16]

H6: Equality of success probability for all strategies for kickers and goalkeepers: Table 5 shows that especially the sides for kickers and goalkeepers have similar success probabilities. For the choice of the centre this is valid to a slightly lower degree.

The actual scoring probability however, corresponds to the expected utility of choosing a certain side. This results from the product of the expected utility after choosing a certain strategy and the probability with which the strategy is chosen. Since the kicker's natural side is in fact connected to less effort (because it is easier to be kicked), a kick to this side should occur more often. However, the exact effort is a priori unidentified and can only be estimated empirically from the observed probabilities of scoring. From

[15] Alternatively, a t-test may be carried out here. This shows in both data sets that the distribution does not significantly differ from a 50:50 distribution ($t = 0.9$).

[16] A t-test however shows a weakened significance ($t = 1.8$).

those observations an optimal mixture of strategies can be concluded. The derivation of this mixed equilibrium is apparently difficult to grasp intuitively (cf. Bar-Eli et al. 2007; Berger 2009; Luhmann 1986). A formal derivation of optimally mixed strategies can therefore be found in the appendix. Following this procedure, the values indicated in table 6 result from the Bundesliga data.[17]

Table 6: Predicted and actual probabilities of strategy choices for kickers and goalkeepers in the German Bundesliga in percentages.

	kicker			goalie		
	left	centre	right	left	centre	right
Predicted	38.6	0.0	61.4	44.5	0.0	55.5
actual	41.5	14.5	44.0	46.4	1.6	55.1

The strategy choice "right" indicates the kick or the jump to the kicker's natural side.

The kickers of the German Bundesliga are stunningly successful in keeping the goalkeepers indifferent towards their three options. However, they too often choose the centre at the expense of the natural side.

Therefore, the predictions for the trained actors on the aggregate level can be confirmed also for interactions with 3×3 options. The expected effects always become apparent. With the test strategy of regarding the hypotheses as statements of frequency the effects are also significant. An exception is hypothesis 6, which can only be tested using point estimations. A certain fuzziness can be noticed there, so that it cannot be distinctly said from which point on the hypothesis would have to be considered falsified. In total, the expected aggregate patterns were found for the trained expert players.

4.1.2 Results: untrained players

With the hypotheses tests for the untrained players a distinction is made between those actors who have no experience in football (absolute beginners, B) and amateurs (A), who - even if briefly or a long time ago - have played football. The observation of these kickers suggests that almost all of them have the ability to kick the ball with enough power in the intended direction. This is not necessarily true for the group of beginners. Although here kickers with insufficient leg power are excluded (see above), observation of the beginners showed that in a minority group the technical and/or physiological abilities were underdeveloped to the point that the observed kicks seemed erratic and

[17]The calculations were made using the software "Gambit" (see http://econweb.tamu.edu/gambit).

hardly realisable in regards to the respective intention. For the empirical analysis of the untrained players it is therefore an a priori assumption that in principle, strategically optimal behaviour is measurable for goalkeepers and amateurs (in this order). This is not valid for the beginners. If they do not demonstrate any optimal behaviour, this may be due to to lacking technical abilities and not necessarily due to not optimal intentions.

The testing is done analogously to the testing of the professional players. Since the data set potentially holds unidentified heterogeneity the hypotheses are tested - if possible - as frequency statements. Only when this is not possible, the probability statement is used.

H1: Independence of kickers' and goalies' strategies. Table 7 and 8 show the common distribution of strategy choices by hardly trained and entirely untrained kickers and goalkeepers. It becomes obvious that in both cases the involved players' decisions are not independent from each other (A: $\chi^2 = 21.7, df = 4, p = 0.000$; B: $\chi^2 = 63.4, df = 4, p = 0.000$). As expected, this is true to a higher degree for the absolute beginners than for the amateurs. In both cases the goalkeepers tend to react to the kickers. The aggregate simultaneity of both decisions is therefore not provided. This does not mean that there are no simultaneous actions of goalkeeper and kicker. Rather it may mirror the above mentioned fact that some kickers in the sample obviously did not have the necessary abilities for a enough powerful kick.

It is a common difficulty with empirical work in the field that not all theoretically necessary conditions can be easily met. The usual approach then is not to cancel the whole analysis, but rather to give an adequate interpretation of the results. I.e. that (1) if it becomes clear that the Minimax theorem is still valid even if one prerequisite for applying it is not fulfilled, then it would be a strong argument in favour of game theoretic analysis. (2) Because the keepers tend to react to the kickers, it is supposed to find the predicted patterns (if anything) with the untrained kickers, that must have made some strategic calculations.

H2: Sequence of strategy combinations: The combination [N, N] is, as predicted, the most probable one (A: 38.6%; B: 37.7%), followed by the combination [L, N] (A: 18.9%; B: 17.8%). The rarest of the four combinations is not - different from what was expected - [L, L] (A: 17.2%; B: 15.1%), but instead (and by far) the combination [N, L] (A: 4.9%; B: 3.4%). It becomes obvious again that the goalkeepers tend to react to the kickers.[18]

H3: Probability of the option "centre": Accordingly, this hypothesis can also not be confirmed. The goalkeepers (A: 15.6%; B: 18.5%) stay in the centre almost as often as the kickers (A: 14.8%; B: 15.1%) shoot the ball there. This can benevolently be interpreted to the effect that the goalkeepers anticipate that the kickers frequently want

[18]This also mirrors the fact that the assumptions for this hypothesis are only partially met.

Table 7: Empirical distribution of amateur kicker and the goalie of strategies in absolute frequencies and percentages.

		goalie							
		left		*centre*		*right*			
kicker	*left*	21	17.2%	7	5.7%	23	18.9%	51	41.8%
	centre	1	0.8%	6	4.9%	11	9.0%	18	14.8%
	right	6	4.9%	6	4.9%	41	38.6%	53	43.4%
		28	23.0%	19	15.6%	75	61.5%	122	100%

The strategy choice "right" indicates the kick or the jump to the kicker's natural side. (Percentages may not add up to 100 due to rounding.)

Table 8: Empirical distribution of completely unexperienced kicker's strategies and the goalies in absolute frequencies and percentages.

		goalie							
		left		*centre*		*right*			
kicker	*left*	22	15.1%	4	2.7%	26	17.8%	52	35.6%
	centre	3	2.1%	17	11.6%	8	5.5%	28	19.2%
	right	5	3.4%	6	4.1%	55	37.7%	66	45.2%
		30	20.5%	27	18.5%	89	61.0%	146	100%

The strategy choice "right" indicates the kick or the jump to the kicker's natural side. (Percentages may not add up to 100 due to rounding.)

to choose the centre due to their own technical deficiencies. In this case, they would however underestimate the fact that the ball does not always travel in the intended direction.

H4: Choice of natural side by goalkeepers and kickers together: For both groups it can be confirmed that the goalkeepers jump more often to the natural side (A: 75; B: 89) than the kickers kick the ball there (A: 53; B: 66). This discrepancy is marginally significant (A: $t = 1.9$; B: $t = 1.8$).

H5: Choice of the natural side by the kicker and the goalkeeper: The kickers in the amateurs group and in the beginners group choose the natural side (A: 53; B: 66) not much more frequently than the left (A: 51; B: 52). This discrepancy is not significant (A: $t = 0.2$; B: $t = 1.3$). This is not valid for the goalkeepers who in both groups jump significantly (A: $t = 5.2$ B: $t = 6.2$) more often to the natural side (A: 75; B: 89) than to the left side (A: 28; B: 30). Although they confirm the hypothesis by that, they

Table 9: Empirical distribution of scoring probabilities of amateur kickers and goalies in percentages.

		goalie			
		left	*centre*	*right*	
kicker	*left*	33.3	57.1	65.2	51.0
	centre	0.0	16.7	63.6	44.4
	right	100.0	50.0	39.0	47.2
		46.4	42.1	50.7	48.4

The strategy choice "right" indicates the kick or the jump to the kicker's natural side. The figures in the cells correspond to the empirical scoring probabilities (i.e. the ratio of scored goals and kicks) for the kicker. The probabilities of saving for the goalkeeper result from the converse probability.

Table 10: Empirical distribution of scoring probabilities of completely unexperienced kickers and the goalies in percentages.

		goalie			
		left	*centre*	*right*	
kicker	*left*	22.7	50.0	65.4	46.2
	centre	66.7	0.0	50.0	21.4
	right	80.0	16.7	21.8	28.8
		36.7	11.1	37.1	32.2

The strategy choice "right" indicates the kick or the jump to the kicker's natural side. The figures in the cells correspond to the empirical scoring probabilities (i.e. the ratio of scored goals and kicks) for the kicker. The probabilities of saving for the goalkeeper result from the converse probability.

probably anticipate only conditionally the kickers' suboptimal behaviour.

H6: Equality of success probability for all strategies of kickers and goalkeepers: Table 11 and 12 show that for both groups of untrained kickers the probabilities of success are not the same for all options. The strategy choice differs rather strong from the predicted optimal rate and no pattern is detectable. The same is valid for the goalkeepers. Their strategy choice also does not indicate optimising behaviour.

Table 11: Predicted and actual probabilities of strategy choice of amateur kickers and goalies in percentages.

	kicker			goalie		
	left	centre	right	left	centre	right
predicted	59.0	0.0	41.0	9.6	90.4	0
actual	41.8	14.8	43.4	23.0	4.9	61.5

The strategy choice "right" indicates the kick or the jump to the kicker's natural side.

Table 12: Predicted and actual probabilities of strategy choices for completely unexperienced kickers and goalies in percentages.

	kicker			goalie		
	left	centre	right	left	centre	right
predicted	69.9	0.0	31.1	36.8	63.2	0
actual	35.6	19.2	45.2	20.5	18.5	61.0

The strategy choice "right" indicates the kick or the jump to the kicker's natural side.

H7: Choice of the centre depending on the technical abilities: The professional kickers chose the centre in 14.5% of all kicks (cf. table 4). For the untrained amateurs this value amounts to 14.8% (cf. table 7) and for the beginners to 19.2% (cf. table 8). The predicted pattern is therefore not detectable. The less gifted kickers do not choose the centre more often in order to make sure that the ball reaches the goal.

For untrained actors kicking a penalty the Minimax theorem proves to be an unsuitable explanation. Only the physiologically caused bias towards the natural side can be confirmed. This failure of Minimax may have empirical as well as theoretical reasons. As outlined above, the data of the untrained actors differ from those of the players of the German Bundesliga in several aspects. Whereas the latter are most valid and the result of the action definitely suggests a player's intention, this is not necessarily so in the first case. This is especially true for the beginners. It is correct to a lesser degree for the

not entirely inexperienced amateurs and above all for the goalkeepers. Especially with the latter, the decision (jump to the left or the right, or stay in the centre) is safely detectable and the intention is easily assignable. The fact that they still do not show strategically optimal behaviour suggests a theoretical problem. (1) The data show that with untrained actors there are some penalty kicks where the players do not act simultaneously, but the goalkeepers react to the kickers' actions. This does not mean that the actors do not find themselves in a circle of expectations *before* kicking. Certainly both players hold their cards close to their chests and do not want to disclose their intentions. However, the two goalkeepers apparently succeed in exploiting the kickers' technical deficiencies. For the lacking confirmation of the hypotheses not only empirical and football-related problems may be presented. The untrained actors are apparently not capable of optimal strategic behaviour in a penalty kick.

4.2 Results: micro level

If the Minimax theorem is interpreted as a prediction for the optimisation of individual behaviour, the hypotheses should also apply on the individual level of single players. This empirical analysis can be carried out solely for the professional players because only with them data about an individual sequence of penalty kicks does exist. Fortunately, for all players the penalty situation is the same, independently of the goalkeepers involved (cf. section 4.1), such that penalties from a specific player can be considered as being independent actions (Chiappori et al. 2002: 1144). Yet, there is an unavoidable reduction in the number of cases. Namely only those players who were involved in a sufficiently high number of penalties during the observation period are relevant for the statistical analysis. Goalkeepers fulfil these conditions more easily since per team there is only one goalkeeper[19] compared to 11 potential penalty kickers.[20] In addition, goalkeepers play more matches per season compared to field players and they tend to have longer careers. Because of this they have a higher chance during the entire sample period to be observed. Subsequently, for the individual analyses a total of 13 goalkeepers who were involved in between 21 and 40 penalty situations were observed. This can still be well substantiated statistically. In contrast, 7 of the 12 observed kickers had less than 21 kicks. However, the statistic analyses presented here are carried out with the necessary caution. In order to not further reduce the case numbers, the few kicks to the centre (a

[19]Note that the goalkeeper cannot be chosen for the task of stopping a penalty. Simply the goalkeeper who is in charge at the moment a penalty is imposed, has to take over this task.

[20]In contrast to the goalie, the kicker of the penalty can be chosen out of all 11 players that are in charge at the moment the team gets a penalty kick assigned. Normally, in a team there are a handful of kickers – very seldom goalkeepers themselves – that take over this task.

total of 25 with the observed kickers) are herewith counted as to the natural right side, with the above mentioned argument that kicks to the centre are often performed with the same kicking technique as kicks to the natural side (cf. also Palacios-Huerta 2003). In return, on the goalkeepers' side, the very few kicks that did not reach the goal or hit the goal frame and therefore did not have to be stopped, are excluded.

$H5_{ind}$: Choice of the natural side by individual kickers and goalkeepers: On the aggregate level it could be confirmed that the natural side is preferred over the "left" one. On the individual level this is clearly not the case. Only 8 out of 12 kickers actually choose their natural side more often than the other one (cf. table 13). The other 4 players to a greater or lesser extent show a significant preference for the "left" side.

The goalkeepers have correct expectations in the respect of not choosing the natural side more often. Only four goalkeepers more frequently jump to the kicker's natural side. Lehmann chooses each side equally often (cf. table 13). Together with the fact that the estimations for the goalkeepers are statistically more valid this leads to the rejection of the hypothesis on the level of single players.

$H6_{ind}$: Equality of success probability on both sides for individual kickers and goalkeepers: Due to the small number of cases Fisher's exact test is used for examination instead of the χ^2-test. This shows that the assumption can be confirmed. 6 out of 12 kickers show a perfect distribution of the scoring probability (cf. table 13). Only for the kickers Ailton and Anderbrügge the hypothesis must be rejected on a nearly significant level (Ailton missed too often on the right, Anderbrügge too often on the left). For the goalkeepers these findings are also apparent. At most Kahn or Kiraly could give the kickers cause for assuming that they have a lower chance of defence on one of the sides rather than on the other (cf. table 13). Because each player is a test of the hypothesis, with 25 tests carried out and an assumed significance level of 0.1, about 2.5 false-negative tests are expected. This accounts for the three rejections of the hypothesis. This is also confirmed by a KS test which shows that the common distribution of all single tests also comes about as a product of coincidental processes, as the p-values show: If the hypothesis of statistical independence and therewith the equality of success probability is rejected, a mistake is made with the likelihood of 82.9% (goalkeepers), 76.2% (kickers) or 61.1% (all players). The predicted equality of the probability of success can herewith be proven on both sides.

From table 13 it can also be concluded that neither the "dead sure" kicker nor the "penalty killer" exists. All the kickers and goalkeepers have similar success rates, which hardly differ from the average scoring rate (cf. also Kuss et al. 2007). The best observed goalkeeper is Reitmaier with a saving rate of 30.0%. Neither Kahn, Lehmann, or Butt

Table 13: Distribution of scored, and stopped penalties, respectively

player	n	no success L	no success R	success L	success R	*sig.*
kicker:						
Ailton	21	0	4	8	9	0.13
Anderbrügge	21	3	2	3	13	0.12
Balakov	21	1	1	11	8	1.00
Butt	29	1	3	11	14	0.62
Cardoso	16	1	1	4	10	1.00
Häßler	19	2	1	9	7	1.00
Heldt	16	2	2	4	8	0.60
Herzog	17	2	1	4	10	0.52
Kirsten	16	1	1	10	4	1.00
Polster	22	0	3	7	12	0.52
Winkler	15	2	2	6	5	1.00
Zorc	20	2	2	7	9	1.00
N_S	233	17	23	84	109	
goalie:						
Butt	23	5	12	2	4	1.00
Golz	37	16	12	6	3	0.71
Heinen	23	10	10	2	1	1.00
Kahn	45	17	20	6	2	0.24
Kiraly	22	5	14	2	1	0.23
Klos	21	7	8	3	3	1.00
Koch	26	6	17	1	2	1.00
Lehmann	30	11	13	4	2	0.65
Pieckenhagen	28	8	12	4	4	0.69
Reck	31	15	12	1	3	0.33
Reitmaier	40	19	9	10	2	0.45
Rost	33	15	13	2	3	0.66
Schmadtke	21	11	9	0	1	0.48
N_T	380	145	161	43	31	

"R" (right) indicates the kick or the jump to the kicker's natural side. The abbreviations stand for: "no success L" = no success with shot to the "left" side (kicker), respectively no success by diving to the "left" side (goalkeeper); ditto for R (natural side). "success L" = scored with shot to the "left" side (kicker), respectively stopped ball by diving to the "left" side (goalkeeper); ditto for R (natural side). "*sig.*" indicates the significance level of Fisher's exact test on differences in the scoring, and stopping probabilities, respectively.

Table 14: runs-test on random choices of the sides in series of penalties

player	n_L^i	n_R^i	$runs_{exp}$	$runs_{act}$	z	p
kicker:						
Ailton	8	13	11	14	1.71	0.09*
Anderbrügge	6	15	10	10	0.52	0.61
Balakov	12	9	11	13	1.01	0.31
Butt	12	17	15	12	-1.00	0.32
Cardoso	5	11	8	10	1.60	0.11
Hässler	11	8	10	8	-0.86	0.39
Heldt	6	10	8	9	0.55	0.58
Herzog	6	11	9	11	1.51	0.13
Kirsten	11	5	8	8	0.38	0.70
Polster	7	15	11	11	0.48	0.63
Winkler	8	7	8	10	1.09	0.27
Zorc	9	11	11	14	1.67	0.09*
goalie:						
Butt	7	16	11	9	-0.63	0.53
Golz	22	15	22	27	1.77	0.08*
Heinen	12	11	13	11	-0.63	0.53
Kahn	23	22	17	14	-1.06	0.29
Kiraly	7	15	11	10	-0.21	0.83
Klos	10	11	11	10	-0.44	0.66
Koch	7	19	12	10	-0.83	0.40
Lehmann	15	15	17	21	1.48	0.14
Pieckenhagen	12	16	15	13	-0.48	0.63
Reck	16	15	24	23	-0.29	0.77
Reitmaier	29	11	17	16	-0.18	0.86
Rost	17	16	19	22	1.18	0.24
Schmadtke	11	10	11	11	0.01	0.99

n_L^i or n_R^i stands for the number of kicks or jumps of the player i to the left or right side. $runs_{exp}$ indicate the number of runs expected under statistical independence and $runs_{act}$ the number of actual runs. The number of runs expected under H_0 arises from rounded values. For small case numbers a continuity correction was carried out. The p-value indicates the probability corresponding to the z-value. For cases marked with * the working hypothesis is rejected with 90% or more.

who in German media, from experts[21] and literature (Leininger and Ockenfels 2007) are considered outstanding when it comes to defending penalties, have saving rates (or a strategic saving behaviour) which stand out significantly from the sample average.

H8: Randomisation in sequence of individual kickers and goalkeepers: This hypothesis is the only one referring exclusively to the individual level of single players. In order to be unpredictable for the opponent the choices of sides in a sequence of penalty situations have to be randomly distributed. This statistical examination is carried out using a runs-test,[22] which examines whether an observed number of runs differs significantly

[21]Kahn and Lehmann were keepers of the national team.

[22]A "run" here is a sequence of identical decisions. If the decision alters a new run starts. In four

from the number of runs which are to be expected in a random choice of sides.

In table 14 the corresponding values for the kickers and goalkeepers are indicated. It becomes obvious that for the kickers Ailton and Zorc the hypothesis of a randomly chosen sequence has to be rejected with a certainty of more than 90%. Cardoso and Herzog are also to be found in the area of rejection. These players change their sides too often and by that illustrate a behaviour which was observed in the laboratory as well. However, for the other eight kickers the predicted hypothesis of random choice cannot be rejected. As with the kickers the runs-test is also carried out for the goalkeepers. This shows that only Golz and Lehmann fail in randomising their sides because they also change the sides too often. For the eleven other goalkeepers the hypothesis can be verified (cf. table 14). Again, with a total of 25 tests carried out and an assumed significance level of 0.1, about 2.5 false-negative tests are expected. This is close to the 4 tests, where the hypothesis is rejected. Contrary to most laboratory results[23] but in accordance with the other examinations of real penalty kicks the game-theoretical prediction of randomisation in series can be verified by that.

Therefore, on an individual level two general hypotheses can be confirmed. This conclusion however, does not apply to the third individual hypothesis on the choice of the natural side (H5), which is rejected. In addition it becomes obvious that the suboptimal decisions in the field differ from the optimum in the same direction which is also detected in laboratory experiments.

5 Training or selection?

From the previous sections it is known that amateurs players perform worse in any aspect (technical skills and strategic abilities) of penalty taking than professional athletes. But neither all the professionals show optimal strategic behaviour. This raises the following question: Is strategically successful penalty taking learned[24], or are gifted players selected into their roles? To answer this question strategically optimal behavior must be distinguished from technically skillful action in penalty taking.

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decisions there are e.g. theoretically four runs possible at maximum (LRLR, or vice versa). This maximum amount of runs is as likely as the minimum number (namely one) of runs. The number of runs which have the highest probability and originate from a random process amount to, in contrast, two or three in four decisions. Therefore there should not be too much alternating so that the process appears to be a random one.

[23] Palacios-Huerta and Volij (2008) form an exception.

[24] This could happen by purposeful training or unconsciously just by routine (cf. e.g. Raab and Johnson 2006; Walker and Wooders 2001).

This can be done with a look to the success rates of of different groups of kickers and goalkeepers. From table 5 it can be seen that the saving rate for very engaged goalkeepers in the individual sample is *lower* (19.5%) than that of all goalkeepers within the observation period (24.4%, calculated from table 13). For the kickers these tables show just the conversed pattern. The kickers who shot many penalties have a *higher* scoring rate of 82.8% on average (Balakov has the highest with 90.5%) compared to the total rate based on all eleven seasons (75.6%). This is important in several respects: (1) It indicates that penalty kicking is mainly a random process which the players cannot escape from (cf. also Kuss et al. 2007). This is however, very often hawked by the players thinking that by making a list they may find out about the opponents' favourite strategies.[25] But apparently what a current goalkeeper of the Swiss national team suspects in an interview seems to be rather the case. After making lists of kickers' strategies he hardly saved any penalties. Only after not paying further attention to the lists and relying only on his gut feeling (say: chance) he succeeded again in saving penalties. (2) Successful behaviour in penalty situations can apparently not be acquired through routine. The results of goalkeepers who were in many of these situations are worse than the overall average. This talent seems to be acquired elsewhere, since the kickers who are often chosen for penalties justify this trust. This fits together with the fact, that successful players do not seem to know correctly how they take their decisions. They rather do that intuitively.

Further hints can be found regarding hypothesis 5 again. H5 is applicable on the aggregate of all observed players, where it is confirmed empirically (cf. section 4.1.1).[26] In addition, this hypothesis is also confirmed for the aggregate macro level of the subsample of the players who often take penalties, and are therefore used for the tests on the micro level. As predicted by H5 these kickers kicked more often to the natural side (132 kicks) than to "left" (101 kicks, significant difference $t = 2.0$). Correspondingly the goalkeepers also chose more often the natural side (192 jumps) than the "left" (188 jumps), though this difference is not significant ($t = 0.2$). However, on the micro level of the individual players of the subsample, $H5_{ind}$ is rejected for 4 out of 12 kickers, and particularly even for 9 out of 13 goalies. Of these goalkeepers, neither the ones that were widely considered to be the best (namely Kahn, Lehmann and Butt, cf. section

[25] E.g., during the World Cup of 2006 there was the commonly held belief, that the German goalkeeper Lehmann was made privy to the kicking directions of his Argentine opponents from a note given to him before the penalty shootout of the quarter-final. Indeed, he stopped three balls and Germany won. But - according to game theoretical predictions – it turned out that Lehmann did not know the kicking directions from this note, but was simply lucky.

[26] Certainly it should be kept in mind that many players in the full sample did not have a chance of behaving suboptimally due to their little participation in penalty kicks.

4.2), neither the one that is actually the best in stopping penalties (Reitmaier) show an optimal strategic performance. This means, that strategic behaviour is not optimized through routine. For the goalkeepers that were involved in most penalties (the ones already mentioned plus Golz and Rost), $H5_{ind}$ cannot be confirmed as well (cf. table 13). For the kickers this pattern is conversed. The best kicker (Balakov) also shows strategically perfect behaviour, and the individual strategic behaviour of kickers is overall better than the one of the goalies. So, players with good strategic abilities seem to have been gifted with this talent. Hence, it is plausible that these players were selected into their roles of taking penalties, rather than having learned it.

This thesis of selection can be substantiated by further consideration: (1) Penalties are not the only situation in football in which mixed strategies have to be used for a maximisation of benefits (cf. Moschini 2004). In fact, the entire game consists considerably of such strategic situations. Therefore suitable talented actors should be successful more often in the game. This consideration is confirmed by the high rate of of left-footed players (36.1%) among professional players. The rate of left-footed people in the general population is only about 10%. As a consequence this rate can also be found in the population of the untrained players (see table 2). I.e. that left-footed players are selected more often into professional football than right-footed players. This may be partly the case because players on the left side of the field benefit from being left-footed. But it may also happen due to the fact that left-footed players are used to encountering right-footed players, particularly in the beginning of their career. The reverse however, is not the case. Therefore, a left-footed player compared to a right-footed player has a relative advantage. This phenomenon is also known in tennis or boxing. In boxing southpaws have a relative advantage over orthodox fighters in the same way that left-handed players in tennis have an advantage over right-handed players.[27]

6 Discussion

In this article the penalty situation is being examined as an example of interactions in which the actors have contrary and therefore by definition selfish interests. It is especially analysed whether trained and untrained players behave in the way of strategically maximising their benefits according to the requirements of the Minimax theorem in this real-life situation. For the empirical examination of the derived hypotheses a data set of trained professional players from the German Bundesliga and a data set of untrained players is used.

[27]Personal communication with Daniel Ackermann, Peter Hobusch and Jochen Berger, Departement of Sports, University of Leipzig.

Regarding the aggregate patterns of interacting players the Minimax predictions for trained professional players can be confirmed. This result is in accordance with evidence from the literature. For the aggregate patterns of untrained players this is not the case. The behaviour of the untrained players cannot be predicted with Minimax. I.e. that these players are potentially exploitable by strategically rational players. For the tests on an individual level of single players, only the data set of professional actors can be used. The results of this examination are ambivalent. The analysed actors do make decisions according to the Minimax predictions in most situations. But, one hypothesis must be rejected. The Minimax solution therefore seems to be a behavioural tendency of single experienced actors.

Minimax therefore only satisfactorily explains the behaviour of trained players but not the behaviour of untrained ones. An evident assumption is that the professional athletes learned this optimal strategic behaviour to different extents. However, examination of the micro level of single trained actors suggests a different explanation. The players did not learn optimal strategic behaviour[28], but rather have been selected into their roles through an evolutionary process. Strategically gifted players asserted themselves over less gifted players in professional sports competition. Doubtlessly all actors in the observed zero-sum-interaction aimed at a strategic maximisation of their benefit. However, this rational motives do not lead directly to aggregate patterns of behaviour that are predicted by the Minimax theorem. For this, to many actors in an unsorted population lack the abilities to reach the aim of being strategically not exploitable. Only after a the long lasting competitive situation of professional sports has selected the accordingly gifted players, Minimax makes suitable prediction about the behaviour of the players on the individual level of single players, as much as on the aggregate level. These selected actors behave as if they decide rationally on an individual level, mostly without being aware of it (cf. Friedman 1953). Hence, the aggregate patterns of behaviour are not the result of a purposeful design, but of an evolutionary process. Proceeding one step further it can be speculated that social institutions that deal with mixed equilibria, tend to promote rational behaviour because they emerged from a similar evolutionary process. In this sense, the Minimax theorem therefore cannot be interpreted as a psychological behaviour pattern. A sociological interpretation in the sense of Coleman (1986) in which not the type of actor but the interaction situation is vital, rather seems to be adequate. Rationality then is not an individual characteristic but can be considered with Vernon Smith (2003) as ecological rationality which arises from the interaction.

Applying this finding to concrete situations, it can be concluded that the Minimax theorem provides correct predictions when experienced experts interact. This may be

[28]For technical and for physiological skills this certainly applies.

the case for the interaction of the police and habitual criminals, tax authorities and tax consultants or in war. For the interaction of unexperienced actors (petty thieves or occasional tax evaders) with experienced ones (police or tax authorities) it can be concluded that the experts will be able to predict and therefore exploit their unexperienced counterparts. At last the interaction of unexperienced actors (like terrorist and their victims) cannot be predicted by Minimax. The observed pattern of these unexperienced actors then may be caused by some non-maximizing, and therefore exploitable behaviour, like e.g. habits, adherence to social norms, or physiologically or psychologically guided heuristics.

References

Bar-Eli M, OH Azar, I Ritov, Y Keidar-Levin and G Schein (2007) Action bias among elite soccer goalkeepers: The case of penalty kicks. *Journal of Economic Psychology* 28: 606–621.

Berger R (2009) Should I Stay or Should I Go? Optimal Decision Making in Penalty Kicks. Comment on Bar-Eli et al. *Working Paper* Nr. 1 LMU Munich, SSRN Paper 1628776.

Berger R and R Hammer (2007a) Die doppelte Kontingenz von Elfmeterschüssen. Eine empirische Analyse. (The double contingency of penalty kicks. An empirical analysis.) *Soziale Welt* 58: 397–418.

Berger R and R Hammer (2007b) Links oder rechts; das ist hier die Frage. Eine spieltheoretische Analyse von Elfmeterschüssen mit Bundesligadaten. (Left or right; that is the question. A game theoretic analysis with data from the Bundesliga) *Working Paper* Nr. 47 University of Leipzig.

Bloomfield R (1994) Learning a Mixed Strategy Equilibrium in the Laboratory. *Journal of Economic Behavior & Organization* 25: 411–436.

Brown JN and RW Rosenthal (1990) Testing the Minimax Hypothesis: A Re-Examination of O'Neill's Game Experiment. *Econometrica* 58: 1065–1081.

Chiappori PA, S Levitt and T Groseclose (2002) Testing Mixed-Strategy Equilibria When Players Are Heterogenous: The Case of Penalty Kicks in Soccer. *American Economic Review* 92: 1138–1151.

Coleman JS (1986) Psychological Structure and Social Structure in Economic Models. In Hogarth, RM and MW Reder (eds.) *Rational Choice. The Contrast Between Economics and Psychology* (pp. 181–186). London: Wiley & Sons.

Dixit A and S Skeath (2004) Games of Strategy. (2^{nd} ed.). New York and London: Norton.

Friedman M (1953) *Essays in Positive Economics*. Chicago: University of Chicago Press.

Ganssmann H (2006) Double Contingency. In Jens Beckert & Milan Zafirovski (eds.), *International Encyclopedia of Economic Sociology* (pp. 151–154). London and New York: Routledge.

Geanakoplos J (1992) Common Knowledge. *Journal of Economic Perspectives* 6: 52–83.

Hsu SH, CY Huang and C-T Tang (2007) Minimax Play at Wimbledon. Comment. *American Economic Review* 97: 517–523.

Johanni S and K. Tschacher (2005) Ist der Elfmeter zu halten? Das Dilemma des Torhüters, mathematisch gesehen. (Can the penalty be saved? The goalkeeper's dilemma, seen mathematically.) *uni.kurier.magazin der Friedrich-Alexander-Universität Erlangen-Nürnberg* 106: 26–28.

Klaassen FJMG and JR Magnus (2001) Are Points in Tennis Independent and Identically Distributed? Evidence from Dynamic Binary Panel Data Model. *Journal of the American Statistical Association* 96: 500–509.

Kovash K and SD Levitt (2009) Professionals Do Not Play Minimax: Evidence from Major League Baseball and the National Football League. *NBER Working Paper* 15347.

Kuss O, A Kluttig and O. Stoll (2007) "The fouled player should not take the penalty himself": An empirical investigation of an old German football myth. *Journal of Sports Science* 25: 963–967.

Leininger W and A. Ockenfels (2007) The Penalty Duel and Institutional Design: Is there a Neeskens-Effect? In P Andersson, P Ayton and C Schmidt (eds.) *Myths and facts about football: The economics and psychology of the world's greatest sport* (pp. 73–93). Cambridge: Scholars Press.

Levitt SD, JA List and DH Reiley (2007) What Happens in the Field Stays in the Field: Professionals Do Not Play Minimax in Laboratory Experiments. *Working Paper* University of Chicago and Arizona.

Luhmann N (1988, 2^{nd} ed.) *Soziale Systeme. Grundriß einer allgemeinen Theorie (Social systems. Layout of a general theory)* Frankfurt a.M.: Suhrkamp.

McKelvey RD, TR Palfrey and RA Weber (2000) The Effects of Payoff Magnitude and Heterogeneity on Behavior in 2x2 Games with Unique Mixed Strategy Equilibria. *Journal of Economic Behavior & Organization* 42: 523–548.

Mookherjee D and B Sopher (2004) Learning Behavior in an Experimental Matching Pennies Game. *Games and Economic Behavior* 7: 62–91.

Moschini G (2004) Nash Equilibrium in Strictly Competitive Games: Live Play in Soccer. *Economic Letters* 85: 365–371.

Nash JF (1950) Equilibrium Points in n-Person Games. *Proceedings of the National Academy of Sciences* 36: 48–49.

von Neumann J (1928) Zur Theorie der Gesellschaftsspiele. (On the theory of parlour games.) *Mathematische Annalen* 100: 295–320.

Ochs J (1995) Games with Unique, Mixed Strategy Equilibria: An Experimental Study. *Games and Economic Behavior* 10: 202–217.

O'Neill B (1987) Nonmetric Test of the Minimax Theory of Two-Person Zerosum Games. *Proceedings of the National Academy of Sciences* 84: 2106–2109.

O'Neill B (1991) Comments on Brown and Rosenthal's Reexamination. *Econometrica* 59: 503–507.

Palacios-Huerta I (2003) Professionals Play Minimax. *Review of Economic Studies* 70: 395–415.

Palacios-Huerta I and Volij O (2008) Experientia Docet: Professionals Play Minimax in Laboratory Experiments. *Econometrica* 76: 71–115.

Raab M and JG Johnson (2006) Implicit Learning as a Means to Intuitive Decision Making in Sports. In T. Betsch, C. Betsch and H. Plessner (eds.), *A New Look on Intuition in Judgement and Decision Making.* Mahwah NJ: Lawrence Erlbaum.

Rapoport A and RH Boebel (1992) Mixed Strategies in Strictly Competitive Games: A Further Test of the Minimax Hypothesis. *Games and Economic Behavior* 4: 261–283.

Rosenthal RW, JM Shachat and M Walker (2003) Hide and Seek in Arizona. *International Journal of Game Theory* 32: 273–293.

Shachat JM (2002) Mixed strategy Play and the Minimax Hypothesis. *Journal of Economic Theory* 104: 189–226.

Smith, VL (2003) Constructivist and Ecological Rationality in Economics. *American Economic Review* 93: 465–508.

Swed F and C Eisenhart (1943) Tables For Testing Randomness Of Grouping In A Sequence of Alternatives. *The Annals of Mathematical Statistics* 14: 66-87.

Tsebelis G (1990) Penalty has no Impact on Crime: A Game Theoretic Analysis. *Rationality and Society* 2: 255–286.

Varian HR (1992) Microeconomic Analysis (3^{nd} ed.). New York and London: Norton.

Walker M and J Wooders (2001). Minimax Play at Wimbledon. *American Economic Review* 91: 1521–1538.

Appendix

Given the following model of penalty kicking in normal form with the strategies {left, centre, right}. a to i indicate the empirical probabilities of scoring (cf. table 5 and 9/19) for the corresponding strategy combinations and p to $\overline{q}$ the optimal distribution of probabilities for the strategy of goalkeeper and kicker resulting from it.

			goalie		
			p	q	$1-p-q$
			left	*centre*	*right*
kicker	$\overline{p}$	*left*	a	b	c
	$\overline{q}$	*centre*	d	e	f
	$1-\overline{p}-\overline{q}$	*right*	g	h	i

In a mixed equilibrium all three strategies must show the same expected utility. Therefore, first the expected utility of the strategy "left" of the *kicker* is equated with the one of his strategy "centre". Thereto the probabilities of the strategies of the *goalkeeper* are used:

$$p \cdot a + q \cdot b + (1-p-q) \cdot c = p \cdot d + q \cdot e + (1-p-q) \cdot f$$

$$p = \frac{c-f}{c-f+d-a} - \frac{e-b+c-f}{c-f+d-a} \cdot q$$

Then the same is done with the kicker's strategies "left" and "right":

$$p \cdot a + q \cdot b + (1-p-q) \cdot c = p \cdot g + q \cdot h + (1-p-q) \cdot i$$

$$p = \frac{c-i}{c-i+g-a} - \frac{h-b+c-i}{c-i+g-a} \cdot q$$

Equating both conditions allows for solving the equation for q :

$$\frac{c-f}{c-f+d-a} - \frac{e-b+c-f}{c-f+d-a} \cdot q = \frac{c-i}{c-i+g-a} - \frac{h-b+c-i}{c-i+g-a} \cdot q$$

$$q = -\frac{id-ia+af-cd+cg-fg}{ia-ib-id+ie+ae-ce-ge-bd-af+cd+bf-ah+bg-cg+ch+dh+fg-fh}$$

Now q can be inserted and the equation can also be solved for p:

$$p = -\frac{ib-ie+ce-bf-ch+fh}{ia-ib-id+ie+ae-ce-ge-bd-af+cd+bf-ah+bg-cg+ch+dh+fg-fh}$$

By inserting the empirical scoring probabilities now the optimal empirical probabilities p, q and $1-p-q$ can be identified, with which the *goalkeeper* should choose the three options{left, centre, right}. Analogously can be proceeded for the expected utility of the *goalkeeper* and the optimal empirical probabilities $\overline{p}$, $\overline{q}$ and $1-\overline{p}-\overline{q}$ can be identified, with which the *kicker* should choose between the options {left, centre, right}.

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